Physics 202

Individual Quizbit | Oscillations and Waves

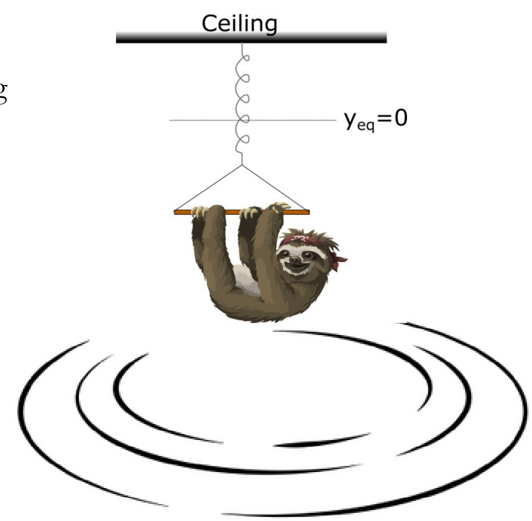
Work individually to produce a single handwritten solution to these questions. The first part of activity is a timed quiz, where you are graded on effort and completeness. Turn that into Gradescope under the associated timed assignment. Then you will have until the end of the week to submit to a separate Gradescope assignment a well organized and thorough solution. Start with fundamental principles and use multiple representations to communicate understanding of the physics.

For question 1 **fill in the square** next to all correct answers. A given problem may have more than one correct answer. Each correctly bubbled answer will receive two points. There are **2** correct answers in this section and only the first **2** filled in answers will be graded. There is no partial credit.

1. Which of the following actions would decrease the period of oscillation? Assume a small angle approximation for the pendulum cases.

   □ (a) Take a pendulum to a planet with a smaller gravitational force.
   x (b) Decrease the length of a pendulum.
   □ (c) Take a pendulum with an amplitude of 10° and reduce it to 5°.
   x (d) Increase the spring constant on an oscillating mass/spring system.
   □ (e) Increase the mass connected to an oscillating mass/spring system.
   □ (f) Increase the energy in an oscillating mass/spring system.

2. Sloan the Sloth (5 kg) is playing on a spring above his favorite watering hole. The spring is the perfect length for him to just barely touch the water while he oscillates up and down. This creates water waves in the pond at the same frequency as the oscillating spring.



   (a) When Sloan is not on the spring, it hangs above the water. After he hangs from the spring, it stretches 68 cm towards the water to a new equilibrium state, where he can now barely touch the water. What is the spring constant of the spring?

   (b) When Sloan starts to oscillate up and down, what is the period of his oscillation?

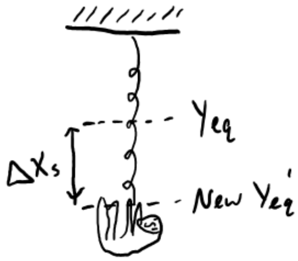
   (c) You notice there are exactly 4 total waves between where Sloan is generating the waves and the edge of the pond, a total distance of about 15 m. What is the speed of the traveling waves?

   (d) If the waves have a total peak to trough height of 20 cm, model them as a 1-D traveling wave traveling in the positive x-direction. Use a +cosine function for your model. Your answer should be in S.I. units and should only be in terms of the variables **x** and **t**.

Sensemaking Follow-up (not due during timed quiz but should be part of final solution)

Assuming you are there at the pond with a tape measure and a smart phone, what is another way you could measure/determine the speed of the traveling waves to check your answer to part (b)?

(a)



$|\vec{F}^s| = k|\Delta x|$

$mg = k\,\Delta X_s$

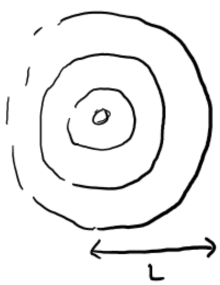
$$k = \frac{mg}{\Delta X_s} = \frac{(5\,kg)(9.8\,m/s^2)}{0.68\,m} = \underline{72.06\,\frac{N}{m}}$$

(b)

$$\left.\begin{aligned} \omega &= \sqrt{\frac{k}{m}} \\ \omega &= \frac{2\pi}{T} \end{aligned}\right\} \quad T = 2\pi\sqrt{\frac{m}{k}} = \underline{1.655\,s}$$

(c)

$$\lambda = \frac{\text{distance}}{\text{oscillation}} = \frac{L}{4} = \frac{15}{4}\,m$$



$$\left.\begin{aligned} v &= f\lambda \\ f &= \frac{1}{T} \end{aligned}\right\} \quad v = \frac{\lambda}{T} = \frac{15\,m}{4(1.655\,s)} = \underline{2.266\,m/s}$$

(d) <u>Model</u> $D(x,t) = D_{max}\cos(kx \pm \omega t)$ (sin or cos)

$$k = \frac{2\pi}{\lambda} = \frac{30\pi}{4}\,m^{-1}, \quad \omega = \sqrt{\frac{k}{m}} = 3.80\,s^{-1}$$

$$\underline{D(x,t) = 10\,cm\,\cos\left(\left(\frac{30\pi}{4}\,m^{-1}\right)x - (3.80\,s^{-1})t\right)}$$

<u>Sensemaking:</u>

tape measure ⇒ distance
phone's clock ⇒ time

} measure out a distance. time how long the peak of one wave takes to travel that distance.

$$v = \frac{\text{dist}}{\text{time}}$$